Hazards of Confined Spaces

for Shipping and Transportation Industries

WorkSafeBC

WORKING TO MAKE A DIFFERENCE

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About WorkSafeBC

WorkSafeBC (the Workers' Compensation Board) is an independent provincial statutory agency governed by a Board of Directors. It is funded by insurance premiums paid by registered employers and by investment returns. In administering the *Workers Compensation Act*, WorkSafeBC remains separate and distinct from government; however, it is accountable to the public through government in its role of protecting and maintaining the overall well-being of the workers' compensation system.

WorkSafeBC was born out of a compromise between B.C.'s workers and employers in 1917 where workers gave up the right to sue their employers or fellow workers for injuries on the job in return for a no-fault insurance program fully paid for by employers. WorkSafeBC is committed to a safe and healthy workplace, and to providing return-to-work rehabilitation and legislated compensation benefits to workers injured as a result of their employment.

WorkSafeBC Prevention Information Line

The WorkSafeBC Prevention Information Line can answer your questions about workplace health and safety, worker and employer responsibilities, and reporting a workplace accident or incident. The Prevention Information Line accepts anonymous calls.

Phone 604 276-3100 in the Lower Mainland, or call 1 888 621-7233 (621-SAFE) toll-free in British Columbia.

To report after-hours and weekend accidents and emergencies, call 604 273-7711 in the Lower Mainland, or call 1 866 922-4357 (WCB-HELP) toll-free in British Columbia.

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WorkSafeBC Publications

Many publications are available on the WorkSafeBC web site. The Occupational Health and Safety Regulation and associated policies and guidelines, as well as excerpts and summaries of the *Workers Compensation Act*, are also available on the web site: WorkSafeBC.com

Some publications are also available for purchase in print:

Phone: 604 232-9704

Toll-free phone: 1 866 319-9704

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Online ordering: WorkSafeBC.com and click on Publications; follow the links for ordering

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What is a confined space?

A confined space is an enclosed or partially enclosed area that is big enough for a worker to enter. It is not designed for someone to work in regularly, but workers may need to enter the confined space for tasks such as inspection, cleaning, maintenance, and repair. A small opening or a layout with obstructions can make entry and exit difficult and can complicate rescue procedures.

Entry into confined spaces can be very hazardous. Unless proper training, equipment, and procedures are in place, workers must not be allowed to enter such spaces. **A worker is considered to have entered a confined space just by putting his or her head across the plane of the opening**. If the confined space contains toxic gases, workers who are simply *near* the opening may be at risk. Often the toxic gases are under pressure because of heat inside the confined space or when gases are generated inside the space. As a result, the concentration of toxic gases near the entrance to the confined space can be high enough to cause death.

It is vital to identify all confined spaces in any workplace. Examples of confined spaces include tanks, silos, storage bins, process vessels, pipelines, sewers, underground utility vaults, and vats – in short, any area that can have a "confined" atmosphere. Workers have died because they did not know they were entering a confined space with a hazardous atmosphere and therefore did not take the necessary precautions.

In addition, an enclosed area in which workers do not normally work could have air that may be hazardous to breathe or the work activity could cause a hazardous atmosphere to develop. Even though rescue would not be complicated by the design of the space (and it does not therefore fit the definition of a confined space), the space may still be **deadly** without air testing and a supply of clean air.

Confined spaces in your workplace

Examples of confined spaces in the shipping and transportation industries:

- Ballast tanks
- Boilers
- Double hulls
- Holds of boats
- Pumping stations
- Storage bins
- Utility vaults
- Pits, sumps
- Storage tanks
- Fuel tanks
- Tank cars
- Tank trucks
- Other similar spaces

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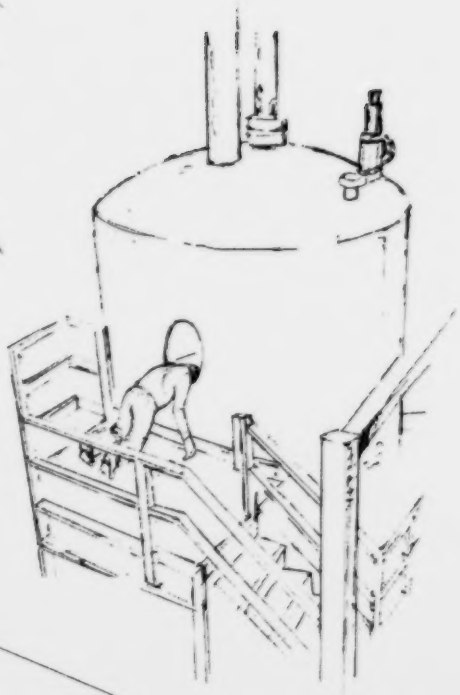
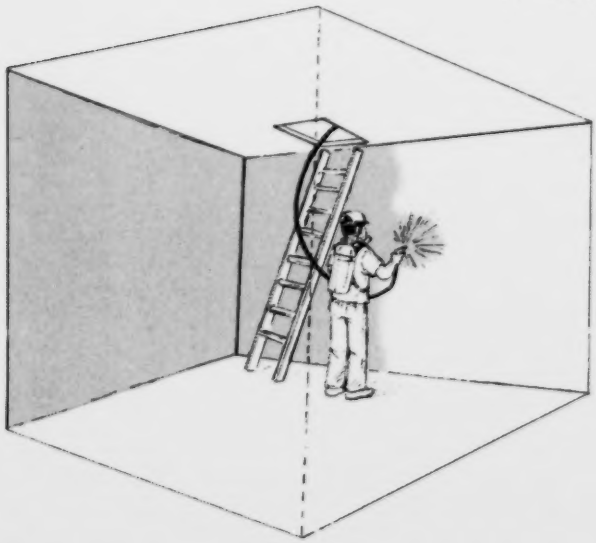
The flotation compartment of a barge is a confined space that may not have enough oxygen to sustain life.



This process vessel at a pulp mill is a confined space. One worker died inside the vessel from lack of oxygen and another died while breathing the air through the opening.



This water cistern is a confined space with limited access and ventilation. While a waterproof coating was being applied, flammable vapours were generated. The vapours ignited, causing an explosion.

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The employer is responsible for determining if confined spaces are present in the workplace. If there are any access points, then they must be secured against entry, or signs (or other effective means) must be used to identify the space and warn workers of the hazards. However, if you think an area without identification is actually a confined space (see previous page), then DO NOT ENTER unless you **know** it is safe to do so.

This book describes the main types of hazards found in confined spaces. Confined spaces may contain hazardous atmospheres, including insufficient oxygen, toxic (poisonous) air, or an explosive atmosphere. These spaces may also have physical hazards that may result, for example, in workers falling, being crushed or buried, or drowning. These hazards may not be obvious. All confined spaces must be carefully assessed to identify every hazard. These assessments must be done by a qualified person familiar with the confined space and the work to be done in that space.

The hazard alerts in this book are based on real accidents that occurred in workplaces around the world.

After reading this book, you should be aware that the air in a confined space must be tested and that all hazards within the space must be identified and safe entry procedures controlling the hazards must be followed before anyone enters. This book is not intended to explain how to eliminate or control all the hazards. A qualified person must develop written procedures for eliminating or safeguarding the hazards. The Occupational Health and Safety Regulation, Part 9, sets out requirements for confined space entry. For more information on confined space entry, visit the Safety at Work section of the WorkSafeBC web site, WorkSafeBC.com.

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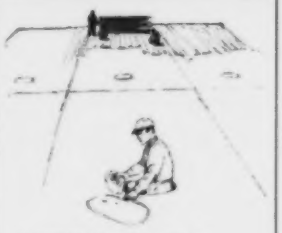
Hazard alert



A welder entered a flotation compartment of a barge hull to check for cracks. Another worker noticed the welder was missing and found him unconscious in the compartment. After calling for help, he also entered the compartment. Three other workers entered the compartment one at a time to attempt rescue. All four would-be rescuers lost consciousness.

Other workers used a rope to remove the unconscious workers. The welder who originally entered the compartment could not be revived. The four workers who attempted rescue all recovered.

An investigation revealed that the sealed compartment of the barge hull did not have enough oxygen to sustain life as a result of corrosion of the steel walls.

Hazardous atmospheres

The atmosphere in a confined space may be hazardous for several reasons. The air may have too little or too much oxygen. The atmosphere may be toxic or explosive. Pages 4–13 describe some of the dangers of hazardous atmospheres. Confined spaces with hazardous atmospheres could also have some of the physical hazards described on pages 14–17.

Once a confined space is identified, its atmosphere must be hazard-rated as **HIGH**, **MODERATE**, or **LOW**. The hazard rating of a confined space must be determined by a qualified person after considering the design, construction, and use of the confined space, the work activities to be performed, and all required engineering controls.

High-hazard atmosphere

An atmosphere that may expose a worker to risk of death, injury, or acute illness, or otherwise impair a worker's ability to escape unaided from a confined space if the ventilation system or respirator fails.

Moderate-hazard atmosphere

An atmosphere that is not clean, respirable air but is not likely to impair a worker's ability to escape unaided from a confined space if the ventilation system or respirator fails.

Low-hazard atmosphere

An atmosphere that is shown by pre-entry testing or is otherwise known to contain clean, respirable air immediately prior to entry into a confined space, and that is not likely to change during the work activity.

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Oxygen: too little or too much

Lack of oxygen is a leading cause of death among workers entering confined spaces. Low oxygen levels cannot be detected by sight or smell. You must test the air for this hazardous condition. A very low level of oxygen can damage the brain and cause the heart to stop after a few minutes.

What causes oxygen deficiency?

Here are some common causes of oxygen deficiency (not enough oxygen) in a confined space:

- Oxygen is used up when metals rust.
- Oxygen is used up during combustion – for example, by propane space heaters, during cutting or welding, and by internal combustion engines.
- Oxygen can be replaced by other gases – for example, welding gases or gases forced into the space to prevention corrosion.
- Micro-organisms use up oxygen – for example, in sewer lines and fermentation vessels.

Too much oxygen is not as common a hazard as low oxygen, but it is also dangerous. Too much oxygen greatly increases the risk of fire or explosion in the confined space. Materials that would not normally catch fire or burn in normal air may do so extremely quickly and easily where there is a high level of oxygen.

The only way to know how much oxygen is present in a confined space is to use an oxygen monitor. **The monitor must be in good working order and properly maintained and calibrated. The alarm must be set at the right level**. Someone trained to use the monitor must test the air before anyone enters the confined space.

An oxygen monitor shows oxygen levels as a percentage of the air. Air contains 20.9% oxygen.

NOTE: As the elevation increases, the amount of oxygen in the air decreases. However, the percentage reading on the oxygen monitor does not change with elevation. Therefore, always consult with a qualified person to determine safe entry procedures. The qualified person will take elevation into account.

Test the oxygen content in the air with an oxygen monitor before you enter a confined space.

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Hazard alert

Not enough oxygen in the tank car

After a tank car was steam-cleaned, tests showed that it had a normal level of oxygen. Ten days later, an employee entered the tank car and passed out. He was wearing a safety harness and lifeline and was rescued. Tests showed low levels of oxygen in the tank car. The tank had rusted, using up much of the oxygen. Rusting is likely to occur on uncoated mild steel, particularly when wet.

The monitor should be tested in clean outside air. If the reading is above or below 20.9% oxygen, there may be a problem with the oxygen sensor or with the calibration of the unit. Do not use this monitor for testing inside the confined space, and do not enter the confined space until a properly calibrated monitor is used.

Clean outside air contains 20.9% oxygen. If the air in the confined space is anything other than 20.9%, the reason should be investigated by a qualified person to ensure the space is safe to enter. It is vitally important to understand what is causing the change in oxygen level. The reason must be identified before workers are allowed to enter the space. For example, many toxic gases present a high hazard to workers even when the concentration is low enough to cause only a very small displacement of oxygen. With some common solvents, a 0.1% change in the oxygen reading could mean the presence of enough toxic gas to cause death or serious injury.

Working in an atmosphere with oxygen levels between 14% and 17% can produce impaired judgment, dizziness, fatigue, and collapse. In oxygen levels lower than this, the one breath you take could have so little oxygen that your muscles can't respond and you won't have enough strength to escape even if you are still conscious. The only safe way to find out whether air in a confined space has enough oxygen is to use a properly calibrated and maintained monitor.

Workers must not enter a confined space containing less than 19.5% oxygen without taking appropriate precautions, including the use of supplied-air respirators.

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Toxic atmospheres

Contaminants in the air can result in an atmosphere that is toxic to workers and may result in injury or death. Some toxic gases typically found in confined spaces are listed in the table on pages 12–13.

In the past, miners would take canaries down into coal mines, since these small birds react quickly to carbon monoxide, a deadly gas. If the canaries breathed a small amount of the gas, they would sway on their perches before falling. This gave miners warning that the deadly gas was present. Today, miners have monitors to let them know when there are toxic substances in the atmosphere.

Hazard alert

Workers die attempting rescue

Two brothers working on board an oil tanker died hours after they fainted and fell while in the cargo tank. They were trying to help a co-worker who had passed out from the vapours.

The concentration of the substance inside the confined space must be determined using a recently calibrated and properly set up air monitor with the correct sensor. Such an air monitor may sound an alarm that will alert the worker before the allowable exposure limit is reached.

In most cases, mechanical ventilation such as fans must be used to ventilate the space, bringing in clean outside air. Additionally, the harmful substance must be eliminated wherever practicable. Air testing and ventilation are the best ways to ensure that workers are not placed at risk from hazardous atmospheres.

At certain concentrations, some substances become **immediately dangerous to life and health** (IDLH). At these levels, even a brief exposure can cause permanent health effects such as brain, heart, or lung damage. Or the substance may make workers dizzy or unconscious so that they cannot escape from the confined space. Some substances have very low IDLH levels. For example, the IDLH level for hydrogen sulfide is only 100 ppm (parts per million).

A list of IDLH levels can be found in the *NIOSH Pocket Guide to Chemical Hazards*, from the U.S. National Institute for Occupational Safety and Health. The *Pocket Guide* can be ordered from NIOSH or downloaded from their web site: **http://www.cdc.gov/niosh/npg/npg.html**

For more information on allowable occupational exposure limits, refer to OHS Guideline G5.48-1, part of the Occupational Health and Safety Regulation materials on the WorkSafeBC web site, WorkSafeBC.com.

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As a result of liquids and solids inside the confined space ...

Liquids may produce hazardous atmospheres if they evaporate – for example, liquid fuel in a tank producing vapours. Dangerous conditions can develop when pockets of gas in waste materials are disturbed during cleaning. For example, an organic material such as manure sludge can release the toxic gas hydrogen sulfide when manure pits are cleaned out. Rotting pulp in tanks also creates hydrogen sulfide. If grains in silos ferment, they use up oxygen and produce deadly gases.

As a result of work done inside the confined space ...

In one-third of accidents involving harmful gases or lack of oxygen, the danger was not present in the confined space when the worker first entered it. Rather, the work in the confined space created the hazardous atmosphere.

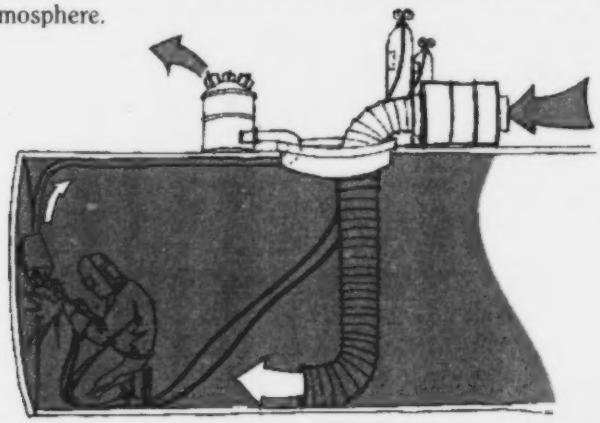
Activities that may lead to the release of harmful substances into the air include grinding, descaling, insulation removal, metal spray applications, rubber lining, painting, fibre-glassing, cutting, welding, and the use of internal combustion engines. Cleaning agents may be toxic, may react with tank residues, or may release a deadly gas from porous surfaces inside the space.

Hazard alert

Cleaning the tank produces deadly gas

Acid was used to clean a zinc cyanide holding tank. Acids react with cyanides to produce hydrogen cyanide, a toxic gas. The five workers who entered the "clean" tank died.

Cleaning a tank that contains dusts can cause the dust to become airborne and create a hazardous atmosphere.



Local exhaust draws the welding fumes out of the confined space. Clean outside air is pumped in.

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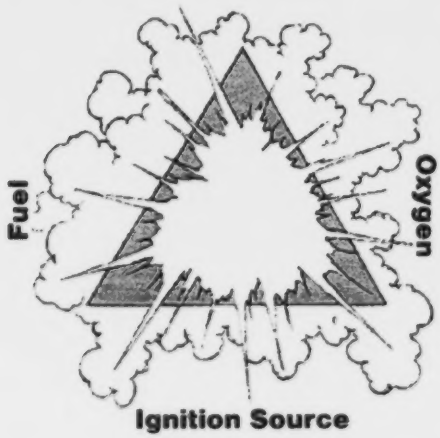
As a result of contamination from outside sources ...

A confined space may be located next to a source of a hazardous contaminant. The contaminant could enter the confined space through porous walls, such as those that may be found in sewers or trenches, or through difficult-to-seal openings such as conduits. Normally, mechanical ventilation is set up to bring outside air into the confined space. If the intake hose is located beside a running vehicle or equipment with an internal combustion engine, the intake hose brings in exhaust fumes.

Explosive atmospheres

Three elements are necessary for a fire or explosion to occur: oxygen, flammable material (fuel), and an ignition source.



Oxygen

Air normally contains 20.9% oxygen, enough oxygen for a fire. However, a higher level of oxygen increases the likelihood of material burning. Air is considered oxygen-enriched at levels above 23%. Enrichment can be caused by improper isolation of oxygen lines, ventilation of the space with oxygen instead of air, or leaks from welding equipment.

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Fuel

Fires and explosions in confined spaces are often caused by gases or vapours igniting. Coal dust and grain dusts may explode when a certain level of dust in the air is reached.

NOTE: Two or more chemicals may react with each other and become explosive.

Containers of fuels such as gasoline and propane should not be taken into a confined space as fuel can easily burn or explode.

Here are some other common substances that can cause explosions or fires in confined spaces:

- Acetylene gas from leaking welding equipment
- Methane gas and hydrogen sulfide gas produced by rotting organic wastes in sewers or tanks
- Hydrogen gas produced by contact between aluminum or galvanized metals and corrosive liquids
- Grain dusts, coal dust
- Solvents such as acetone, ethanol, toluene, turpentine, and xylene, which may have been introduced into the space through spills or by improper use or disposal

A trained person must test the atmosphere for gases and vapours that will burn or explode. You cannot always see or smell these dangerous gases and vapours. If any measurable explosive atmosphere is detected, the air must be further evaluated by a qualified person to ensure that it is safe to enter the confined space.

Hazard alert

Barge tank explodes

One person was killed and seven others were injured in a blast in a tank of a barge. The tank was being repaired, and paint was being applied while welding was going on in the adjacent chamber. Flammable vapour from the paint spread to the adjacent chamber, resulting in a fire and the blast.

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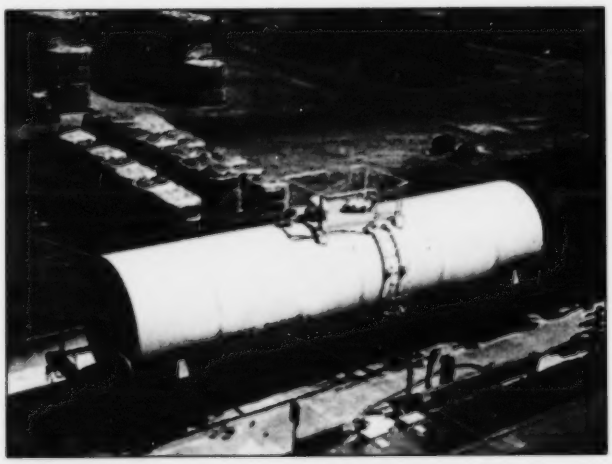
Ignition sources

Ignition sources include:

- Open flames
- Welding arcs
- Hot surfaces
- Lighting
- Sparks from metal impact
- Arcing of electrical motors
- Discharge of static electricity
- Chemical reaction

Many processes can generate static charge, including steam cleaning, purging, and ventilation procedures. To reduce the risks from these ignition sources, use non-sparking tools and ensure all equipment is bonded or grounded properly.



A tank car is a confined space that may present several hazards. If the tank is rusting inside, there might not be enough oxygen. The tank might contain a toxic or explosive atmosphere. If cleaning or welding is being done inside the tank, hazardous gases might be produced. Before anyone enters the tank, the atmosphere must be tested and the space must be ventilated if necessary.

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Gases that may be in your workplace

Contaminant	*What is the MAIN danger?*	*What does it look/ smell like?*
Argon (Ar)	Displaces oxygen May accumulate at bottom	Colourless, odourless
Carbon dioxide (CO_2)	Displaces oxygen Toxic May accumulate at bottom	Colourless, odourless
Carbon monoxide (CO)	Toxic — asphyxiant (causing suffocation)	Colourless, odourless (NO WARNING)
Chlorine (Cl_2)	Toxic — lung and eye irritant May accumulate at bottom	Greenish yellow colour; sharp pungent odour
Gasoline vapours	Fire and explosion May accumulate at bottom	Colourless; sweet odour
Hydrogen sulfide (H_2S)	Extremely flammable Very toxic — causes lung failure May accumulate at bottom	Colourless; rotten egg odour*
Methane (CH_4)	Fire and explosion May accumulate at top	Colourless, odourless (NO WARNING)
Nitrogen (N_2)	Displaces oxygen	Colourless, odourless (NO WARNING)
Nitrogen dioxide (NO_2)	Toxic — severe lung irritant May accumulate at bottom	Reddish brown; pungent odour
Sulfur dioxide (SO_2)	Toxic — severe lung irritant May accumulate at bottom	Colourless; rotten, suffocating odour
Oxygen (O_2)	Low levels — asphyxiant High levels — causes spontaneous combustion, explosion	Colourless, odourless

* Exposure deadens the sense of smell, which means you could be walking TOWARD rather than AWAY from the source and not know it!

NOTE: Combining chemicals may result in a toxic gas being released. Always read the Material Safety Data Sheet to get the information you need about mixing two products.

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Explosive or flammable?	*Industry examples*
NO	Used when welding inside confined space.
NO	Fermentation process in wine storage and fermentation tanks.
YES	Produced by gas or propane.
NO	Could leak into confined space from nearby tanks or piping containing chlorine; piping inflows.
YES, VERY!	Use of gasoline inside a confined space; vapours from spills of gasoline nearby.
YES	Rotting matter has bacteria generating H_2S. In pulp and paper mills, sewers, treatment plants.
YES, VERY!	Rotting matter will generate methane. In sewers, storage tanks.
NO	Inerting a vessel to displace the oxygen to prevent corrosion. In boilers, storage tanks.
NO	Produced by internal combustion engines, tools, and equipment that run on gasoline, propane, or diesel.
NO	Nearby tanks or piping containing sulfur dioxide that could leak; piping inflows.
Supports combustion	Bacteria, rusting, and internal combustion engines will use up oxygen; other gases can replace oxygen. In ballast tanks, boilers, double hulls, utility vaults, septic tanks, vats, manure pits, wine storage and fermentation tanks, reaction vessels, storage tanks, fuel tanks, tank cars, tank trucks, kilns. Welding inside any confined space may decrease the level of oxygen.

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Physical hazards

Loose and unstable materials

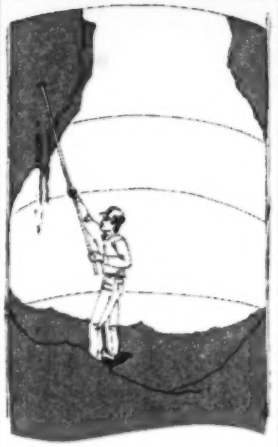
Whenever unstable solids made of small particles like sand or grain are stored in enclosures, there is a danger of the materials flowing onto workers and trapping or burying them. Examples of these confined spaces are sand bins, wood chip or sawdust bins, storage or grain silos, and potash feed systems.

Granular materials, particularly if moist, can form bridges (or shoulders) above workers. If jarred, these can collapse onto a worker.

Bins and hoppers in which materials are conveyed or augered into the bin are particularly dangerous. A worker may be trapped or crushed when material is accidentally discharged into an empty bin or hopper.

The design of these confined spaces may increase the danger of being trapped or buried. For example, in an empty hopper with a floor that slopes steeply to a vertical chute, a worker can slide into the chute and become trapped there.

Hazard alert



A worker was inside a sand bin attempting to free material hung up on the sides. The sand caved in, burying the worker and suffocating him.

Wherever there are loose, unstable materials that could trap or bury you, a qualified person must inspect the space and assess the hazards. Do not enter until the hazard has been eliminated or controlled. Specific training and safety precautions must be in place before you enter.

Slip, trip, and fall hazards

The space you are about to enter may have a hatchway that is difficult to squeeze through, and ladders for ascending or descending. You are therefore at risk of falling while getting into the space as well as while you are inside. In addition, the flooring of tanks or other wet environments or the rungs of a ladder may be very slippery.

If the hazard cannot be eliminated and there is a danger of falling from a height, a fall protection system (such as guardrails or a harness and lifeline) may be needed.

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Falling objects

In a confined space there may be the danger of being struck by falling objects such as tools or equipment, particularly if access ports or workstations are located above workers.

If workers might be exposed to the hazard of falling objects, safe work procedures must be put in place to prevent this. For example, schedule work activity so that no worker is working above another, and lower equipment and tools into the space *before* workers enter and remove them *after* workers leave the space.

Moving parts of equipment and machinery

Mechanical equipment such as augers, mixers, or rotating tanks can be dangerous if activated or not secured. Residual energy, such as gravity or accumulated pressure, may also pose a risk unless the equipment is locked out and de-energized. This must be done by following a written lockout procedure that is specific for each piece of equipment and that states each place where a lock must be applied. Even when the power is shut off and the equipment is locked out at control points, unsecured equipment can move, especially if it is out of balance.

Before doing any work in confined spaces:

- Shut the power off
- Ensure that the equipment is locked out at control points
- Test the lockout
- Secure any equipment that can move, even when it has been locked out

Hazard alert

Worker crushed by dried concrete

Two workers entered a mixing drum on a concrete delivery truck and chipped away dried concrete on one side. The imbalance caused the drum to rotate slowly. One worker climbed out and started the engine to reposition the drum, crushing the second worker, who was just getting out.

Electrical shock

Electrical shock can result from defective extension cords, welding cables, or other electrical equipment. Work done in metal enclosures or in wet conditions can be particularly dangerous. Install ground fault circuit interrupters (GFCIs) or use assured grounding where there may be a danger of electrical shock. All electrical sources that pose a hazard to workers inside the space **must** be locked out following the written lockout procedure for the particular confined space.

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Substances entering through piping

Piping adjacent to a confined space could contain liquids or gases or other harmful substances. If these substances enter the confined space, the hazards may include:

- Toxic gases
- Burns from hot substances
- Drowning
- Being trapped, crushed, or buried

Substances must be prevented from entering the confined space through piping. This is done by "isolating" the piping from the confined space. The method often involves disconnecting the piping or putting solid plates to block off the piping from the confined space. If valves are used to isolate the piping, a special double-block system must be used so that nothing can leak into the confined space. Section 9.18.1 of the Regulation describes exemptions to the prohibition on using valves alone to isolate piping.

Poor visibility

Poor visibility increases the risk of accidents and makes it harder for a standby person to see a worker who may be in distress. If poor visibility results from inadequate lighting, the light levels should be increased (although area lighting is not always required). If activities such as sandblasting or welding result in poor visibility, appropriate ventilation may be needed to reduce harmful substances in the air.

If portable lighting is used where there may be an explosive atmosphere, the lighting must be "explosion-proof." (The *Canadian Electrical Code* has a description of lighting that is approved for use in explosive atmospheres.)

Emergency lighting such as flashlights or battery-operated area units must be provided where necessary, so that workers can locate exits and escape.

Temperature extremes

Special precautions are needed before workers enter equipment such as boilers, reaction vessels, and low-temperature systems. A qualified person must provide these procedures. Allow enough time for cooling of confined spaces that have been steam-cleaned.

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Noise

Noise produced in confined spaces can be particularly harmful because of reflection off walls. Noise levels from a source inside a small confined space can be up to 10 times greater than the same source placed outdoors. If the noise levels cannot be reduced, proper hearing protection **must** be worn where necessary.

Hazard alert

Noise causes hearing loss

A boilermaker removing tubes inside a heat exchanger with the aid of a pneumatic tool was exposed to 120 decibels of noise. This was sufficient to cause major temporary hearing loss after a few minutes of exposure.

Risk of drowning

Confined spaces should be fully drained or dry when entered. Spaces that are not fully drained or dry may pose a risk of drowning. The risk of drowning in a vat or tank with a large amount of liquid is easily recognized. However, workers have drowned in small pools of liquid. For example, insufficient oxygen, the presence of a toxic gas, or a blow to the head can make workers unconscious. Workers who have fallen face-down into a small pool of water have drowned.

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Confined space entry program

Before workers perform work in a confined space, the employer **must** prepare and implement a written confined space entry program.

The identification, evaluation, and control of confined space hazards are often quite complex. For assistance in assessing the hazards and preparing a written confined space entry program, consult a qualified occupational health and safety professional. The health and safety professional can tell you what to do to make it safe to enter a confined space, including providing the appropriate air-testing equipment, and explaining the portable air-moving device and the personal protective equipment to be used.

A well-thought-out rescue plan, proper equipment, and training and practice sessions are key to keeping workers safe if they must enter a confined space.

The confined space entry program **must** include the following:

- An assignment of **responsibilities**.
- A list of each confined space or group of similar spaces, and a **written hazard assessment** of those spaces prepared by a qualified person.

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- **Written safe work procedures** for entry into and work in each of the confined spaces. Each procedure must be written specifically for each of the hazards that exist in each space during each entry.
- The **equipment** necessary for each entry must also be provided, including testing devices, air-moving devices, isolation and lockout devices, and personal protective equipment.
- A **signed** permit where required.
- **Training** of employees.
- A **rescue plan**.

REMEMBER!

Every worker has the right to refuse unsafe work. If you believe the space is unsafe to enter, do not enter it. Make sure all the safety precautions are in place.

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Notes

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Mailing Address:
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Vancouver BC V6B 5L5

After Hours
Health & Safety Emergency
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1 866 922-4357 (WCB-HELP)

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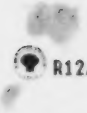
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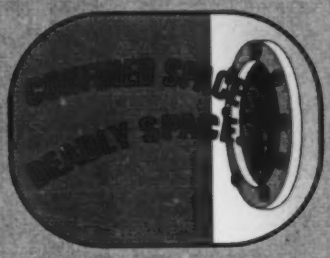
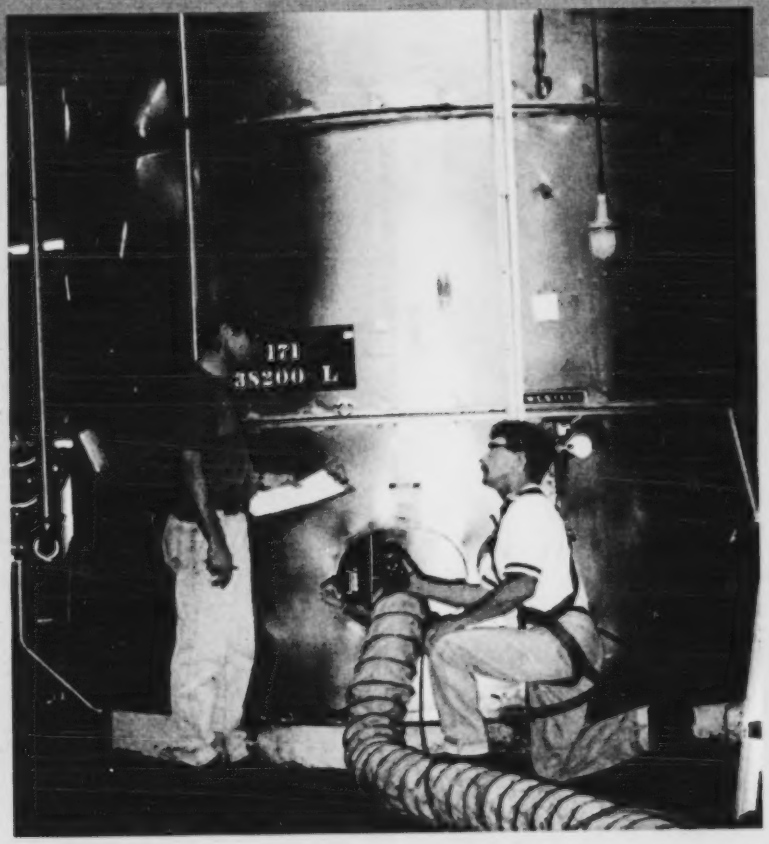


Hazards of Confined Spaces
for Food and Beverage Industries



WORK SAFE BC

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Workers' Compensation Board of B.C.

About WorkSafeBC

WorkSafeBC (the Workers' Compensation Board) is an independent provincial statutory agency governed by a Board of Directors. It is funded by insurance premiums paid by registered employers and by investment returns. In administering the *Workers Compensation Act*, WorkSafeBC remains separate and distinct from government; however, it is accountable to the public through government in its role of protecting and maintaining the overall well-being of the workers' compensation system.

WorkSafeBC was born out of a compromise between B.C.'s workers and employers in 1917 where workers gave up the right to sue their employers or fellow workers for injuries on the job in return for a no-fault insurance program fully paid for by employers. WorkSafeBC is committed to a safe and healthy workplace, and to providing return-to-work rehabilitation and legislated compensation benefits to workers injured as a result of their employment.

WorkSafeBC Prevention Information Line

The WorkSafeBC Prevention Information Line can answer your questions about workplace health and safety, worker and employer responsibilities, and reporting a workplace accident or incident. The Prevention Information Line accepts anonymous calls.

Phone 604 276-3100 in the Lower Mainland, or call 1 888 621-7233 (621-SAFE) toll-free in British Columbia.

To report after-hours and weekend accidents and emergencies, call 604 273-7711 in the Lower Mainland, or call 1 866 922-4357 (WCB-HELP) toll-free in British Columbia.

HAZARDS OF CONFINED SPACES

for Food and Beverage Industries

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WorkSafeBC Publications

Many publications are available on the WorkSafeBC web site. The Occupational Health and Safety Regulation and associated policies and guidelines, as well as excerpts and summaries of the *Workers Compensation Act*, are also available on the web site: WorkSafeBC.com

Some publications are also available for purchase in print:

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What is a confined space?

A confined space is an enclosed or partially enclosed area that is big enough for a worker to enter. It is not designed for someone to work in regularly, but workers may need to enter the confined space for tasks such as inspection, cleaning, maintenance, and repair. A small opening or a layout with obstructions can make entry and exit difficult and can complicate rescue procedures.

Entry into confined spaces can be very hazardous. Unless proper training, equipment, and procedures are in place, workers must not be allowed to enter such spaces. **A worker is considered to have entered a confined space just by putting his or her head across the plane of the opening**. If the confined space contains toxic gases,workers who are simply *near* the opening may be at risk. Often the toxic gases are under pressure because of heat inside the confined space or when gases are generated inside the space. As a result, the concentration of toxic gases near the entrance to the confined space can be high enough to cause death.

It is vital to identify all confined spaces in any workplace. Examples of confined spaces include tanks, silos, storage bins, process vessels, pipelines, sewers, underground utility vaults, and vats – in short, any area that can have a "confined" atmosphere. Workers have died because they did not know they were entering a confined space with a hazardous atmosphere and therefore did not take the necessary precautions.

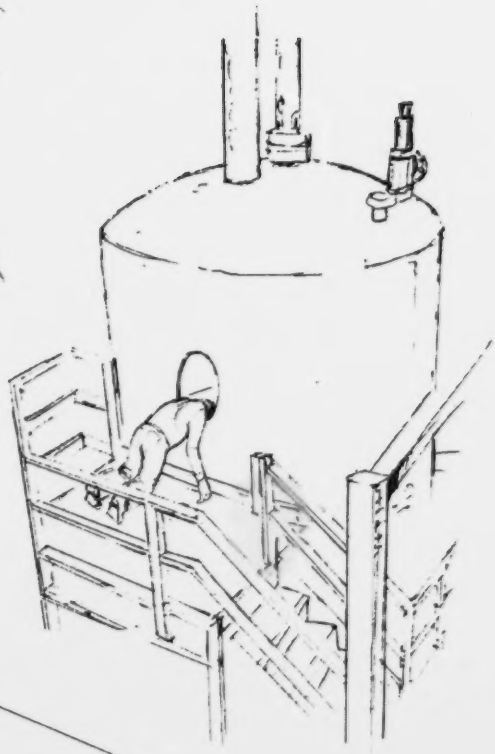
In addition, an enclosed area in which workers do not normally work could have air that may be hazardous to breathe or the work activity could cause a hazardous atmosphere to develop. Even though rescue would not be complicated by the design of the space (and it does not therefore fit the definition of a confined space), the space may still be **deadly** without air testing and a supply of clean air.

Confined spaces in your workplace

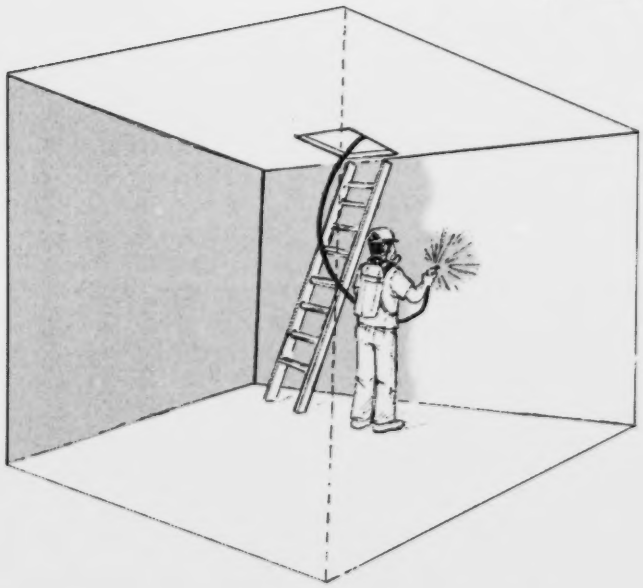
Some examples of confined spaces in the food and beverage industries:

- Storage tanks and bins
- Vats
- Utility vaults
- Pits, sumps
- Fuel tanks
- Grape presses and crushers
- Fermentation tanks and vessels
- Other similar spaces

The flotation compartment of a barge is a confined space that may not have enough oxygen to sustain life.



This process vessel at a pulp mill is a confined space. One worker died inside the vessel from lack of oxygen and another died while breathing the air through the opening.



This water cistern is a confined space with limited access and ventilation. While a waterproof coating was being applied, flammable vapours were generated. The vapours ignited, causing an explosion.

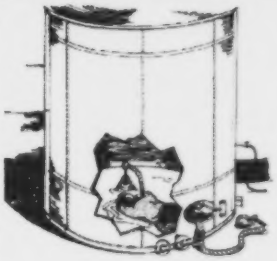
The employer is responsible for determining if confined spaces are present in the workplace. If there are any access points, then they must be secured against entry, or signs (or other effective means) must be used to identify the space and warn workers of the hazards. However, if you think an area without identification is actually a confined space (see previous page), then DO NOT ENTER unless you **know** it is safe to do so.

This book describes the main types of hazards found in confined spaces. Confined spaces may contain hazardous atmospheres, including insufficient oxygen, toxic (poisonous) air, or an explosive atmosphere. These spaces may also have physical hazards that may result, for example, in workers falling, being crushed or buried, or drowning. These hazards may not be obvious. All confined spaces must be carefully assessed to identify every hazard. These assessments must be done by a qualified person familiar with the confined space and the work to be done in that space.

The hazard alerts in this book are based on real accidents that occurred in workplaces around the world.

After reading this book, you should be aware that the air in a confined space must be tested and that all hazards within the space must be identified and safe entry procedures controlling the hazards must be followed before anyone enters. This book is not intended to explain how to eliminate or control all the hazards. A qualified person must develop written procedures for eliminating or safeguarding the hazards. The Occupational Health and Safety Regulation, Part 9, sets out requirements for confined space entry. For more information on confined space entry, visit the Health and Safety Centre on the WorkSafeBC web site: www.worksafebc.com.

Hazard alert



A beverage warehouse worker was preparing to re-clean a beverage storage tank. This tank had been previously cleaned and purged with nitrogen gas. The worker crawled through a small manhole to position the spray ball in the centre of the tank in order to spray the inside walls with detergent. After approximately five minutes in the tank, he was found unconscious and could not be revived.

The nitrogen had displaced oxygen in the air inside the tank, and there was not enough oxygen to sustain life. The air in the tank was not tested for oxygen content before entry.

Hazardous atmospheres

The atmosphere in a confined space may be hazardous for several reasons. The air may have too little or too much oxygen. The atmosphere may be toxic or explosive. Pages 4–13 describe some of the dangers of hazardous atmospheres. Confined spaces with hazardous atmospheres could also have some of the physical hazards described on pages 14–17.

Once a confined space is identified, its atmosphere must be hazard-rated as **HIGH**, **MODERATE**, or **LOW**. The hazard rating of a confined space must be determined by a qualified person after considering the design, construction, and use of the confined space, the work activities to be performed, and all required engineering controls.

High-hazard atmosphere

An atmosphere that may expose a worker to risk of death, injury, or acute illness, or otherwise impair a worker's ability to escape unaided from a confined space if the ventilation system or respirator fails.

Moderate-hazard atmosphere

An atmosphere that is not clean, respirable air but is not likely to impair a worker's ability to escape unaided from a confined space if the ventilation system or respirator fails.

Low-hazard atmosphere

An atmosphere that is shown by pre-entry testing or is otherwise known to contain clean, respirable air immediately prior to entry into a confined space, and that is not likely to change during the work activity.

Oxygen: too little or too much

Lack of oxygen is a leading cause of death among workers entering confined spaces. Low oxygen levels cannot be detected by sight or smell. You must test the air for this hazardous condition. A very low level of oxygen can damage the brain and cause the heart to stop after a few minutes.

What causes oxygen deficiency?

Here are some common causes of oxygen deficiency (not enough oxygen) in a confined space:

- Oxygen is used up when metals rust.
- Oxygen is used up during combustion – for example, by propane space heaters, during cutting or welding, and by internal combustion engines.
- Oxygen can be replaced by other gases – for example, welding gases or gases forced into the space to prevention corrosion.
- Micro-organisms use up oxygen – for example, in sewer lines and fermentation vessels.

Too much oxygen is not as common a hazard as low oxygen, but it is also dangerous. Too much oxygen greatly increases the risk of fire or explosion in the confined space. Materials that would not normally catch fire or burn in normal air may do so extremely quickly and easily where there is a high level of oxygen.

The only way to know how much oxygen is present in a confined space is to use an oxygen monitor. **The monitor must be in good working order and properly maintained and calibrated. The alarm must be set at the right level**. Someone trained to use the monitor must test the air before anyone enters the confined space.

An oxygen monitor shows oxygen levels as a percentage of the air. Air contains 20.9% oxygen.

NOTE: As the elevation increases, the amount of oxygen in the air decreases. However, the percentage reading on the oxygen monitor does not change with elevation. Therefore, always consult with a qualified person to determine safe entry procedures. The qualified person will take elevation into account.

Test the oxygen content in the air with an oxygen monitor before you enter a confined space.

Hazard alert

Not enough oxygen in fermentation tank

The contents of a fermentation tank were drained and pumped into a separator, leaving about 30–45 cm (12–18 inches) of fermented slurry in the bottom. A worker was hosing down the interior and it is believed he fell in. A supervisor heard the worker trying to get out and threw him a rope. It was approximately two hours before the worker could be removed. By that time, the worker had died from lack of oxygen.

The monitor should be tested in clean outside air. If the reading is above or below 20.9% oxygen, there may be a problem with the oxygen sensor or with the calibration of the unit. Do not use this monitor for testing inside the confined space, and do not enter the confined space until a properly calibrated monitor is used.

Clean outside air contains 20.9% oxygen. If the air in the confined space is anything other than 20.9%, the reason should be investigated by a qualified person to ensure the space is safe to enter. It is vitally important to understand what is causing the change in oxygen level. The reason must be identified before workers are allowed to enter the space. For example, many toxic gases present a high hazard to workers even when the concentration is low enough to cause only a very small displacement of oxygen. With some common solvents, a 0.1% change in the oxygen reading could mean the presence of enough toxic gas to cause death or serious injury.

Working in an atmosphere with oxygen levels between 14% and 17% can produce impaired judgment, dizziness, fatigue, and collapse. In oxygen levels lower than this, the one breath you take could have so little oxygen that your muscles can't respond and you won't have enough strength to escape even if you are still conscious. The only safe way to find out whether air in a confined space has enough oxygen is to use a properly calibrated and maintained monitor.

Workers must not enter a confined space containing less than 19.5% oxygen without taking appropriate precautions, including the use of supplied-air respirators.

Toxic atmospheres

Contaminants in the air can result in an atmosphere that is toxic to workers and may result in injury or death. Some toxic gases typically found in confined spaces are listed in the table on pages 12–13.

In the past, miners would take canaries down into coal mines, since these small birds react quickly to carbon monoxide, a deadly gas. If the canaries breathed a small amount of the gas, they would sway on their perches before falling. This gave miners warning that the deadly gas was present. Today, miners have monitors to let them know when there are toxic substances in the atmosphere.

The concentration of the substance inside the confined space must be determined using a recently calibrated and properly set up air monitor with the correct sensor. Such an air monitor may sound an alarm that will alert the worker before the allowable exposure limit is reached.

Hazard alert

Two workers die in a vat

A worker was trying to retrieve a tote from inside a vat of waste chicken parts by using a boatswain chair and a hook and line attached to a crane. The vat was 3 metres (10 feet) deep. The worker was overcome by the toxic atmosphere and fell into the vat. A second worker tried to rescue the fallen worker using the same system. He too was overcome and fell into the contents of the vat. Both men died.

In most cases, mechanical ventilation such as fans must be used to ventilate the space, bringing in clean outside air. Additionally, the harmful substance must be eliminated wherever practicable. Air testing and ventilation are the best ways to ensure that workers are not placed at risk from hazardous atmospheres.

At certain concentrations, some substances become **immediately dangerous to life and health** (IDLH). At these levels, even a brief exposure can cause permanent health effects such as brain, heart, or lung damage. Or the substance may make workers dizzy or unconscious so that they cannot escape from the confined space. Some substances have very low IDLH levels. For example, the IDLH level for hydrogen sulfide is only 100 ppm (parts per million).

A list of IDLH levels can be found in the *NIOSH Pocket Guide to Chemical Hazards*, from the U.S. National Institute for Occupational Safety and Health. The *Pocket Guide* can be ordered from NIOSH or downloaded from their web site: **http://www.cdc.gov/niosh/npg/npg.html**

For more information on allowable occupational exposure limits, refer to OHS Guideline G5.48-1, part of the Occupational Health and Safety Regulation materials on the WorkSafeBC web site: www.worksafebc.com.

As a result of liquids and solids inside the confined space ...

Liquids may produce hazardous atmospheres if they evaporate – for example, liquid fuel in a tank producing vapours. Dangerous conditions can develop when pockets of gas in waste materials are disturbed during cleaning. For example, an organic material such as manure sludge can release the toxic gas hydrogen sulfide when manure pits are cleaned out. Rotting pulp in tanks also creates hydrogen sulfide. If grains in silos ferment, they use up oxygen and produce deadly gases.

As a result of work done inside the confined space ...

In one-third of accidents involving harmful gases or lack of oxygen, the danger was not present in the confined space when the worker first entered it. Rather, the work in the confined space created the hazardous atmosphere.

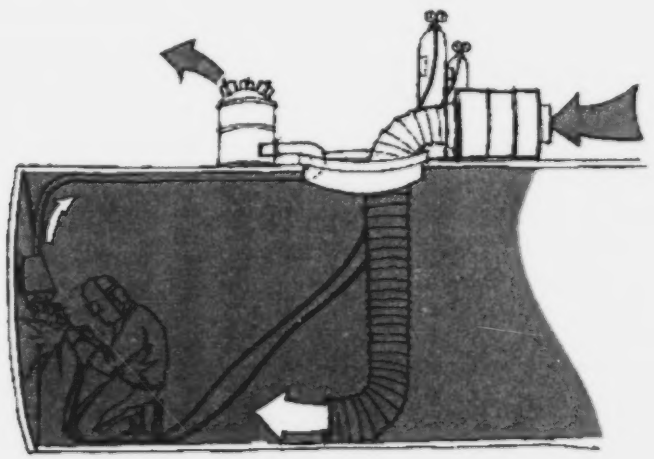
Activities that may lead to the release of harmful substances into the air include grinding, descaling, insulation removal, metal spray applications, rubber lining, painting, fibre-glassing, cutting, welding, and the use of internal combustion engines. Cleaning agents may be toxic, may react with tank residues, or may release a deadly gas from porous surfaces inside the space.

Cleaning a tank that contains dusts can cause the dust to become airborne and create a hazardous atmosphere.

Hazard alert

Argon gas replaces oxygen to kill bacteria

Argon gas was used to displace oxygen as part of a cleaning process to kill bacteria in a tank in a flaxseed oil bottling plant. Two workers died when entering the tank. The company did not provide training, respirators, communications gear, or emergency rescue equipment.



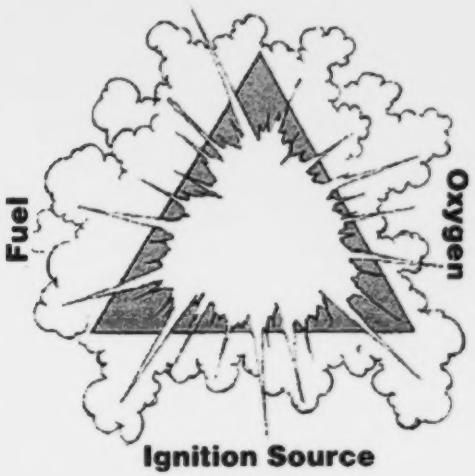
Local exhaust draws the welding fumes out of the confined space. Clean outside air is pumped in.

As a result of contamination from outside sources ...

A confined space may be located next to a source of a hazardous contaminant. The contaminant could enter the confined space through porous walls, such as those that may be found in sewers or trenches, or through difficult-to-seal openings such as conduits. Normally, mechanical ventilation is set up to bring outside air into the confined space. If the intake hose is located beside a running vehicle or equipment with an internal combustion engine, the intake hose brings in exhaust fumes.

Explosive atmospheres

Three elements are necessary for a fire or explosion to occur: oxygen, flammable material (fuel), and an ignition source.



Oxygen

Air normally contains 20.9% oxygen, enough oxygen for a fire. However, a higher level of oxygen increases the likelihood of material burning. Air is considered oxygen-enriched at levels above 23%. Enrichment can be caused by improper isolation of oxygen lines, ventilation of the space with oxygen instead of air, or leaks from welding equipment.

Fuel

Fires and explosions in confined spaces are often caused by gases or vapours igniting. Coal dust and grain dusts may explode when a certain level of dust in the air is reached.

NOTE: Two or more chemicals may react with each other and become explosive.

Containers of fuels such as gasoline and propane should not be taken into a confined space as fuel can easily burn or explode.

Here are some other common substances that can cause explosions or fires in confined spaces:

- Acetylene gas from leaking welding equipment
- Methane gas and hydrogen sulfide gas produced by rotting organic wastes in sewers or tanks
- Hydrogen gas produced by contact between aluminum or galvanized metals and corrosive liquids
- Grain dusts, coal dust
- Solvents such as acetone, ethanol, toluene, turpentine, and xylene, which may have been introduced into the space through spills or by improper use or disposal

A trained person must test the atmosphere for gases and vapours that will burn or explode. You cannot always see or smell these dangerous gases and vapours. If any measurable explosive atmosphere is detected, the air must be further evaluated by a qualified person to ensure that it is safe to enter the confined space.

Hazard alert

Explosion kills one and seriously injures another

A worker was inside a water cistern applying a flammable, waterproof coating using a truck-mounted spray system. An explosion occurred, possibly from a discharge of static electricity. The worker at the vent opening suffered third-degree burns to his face, ears, and hand. The worker inside suffered third-degree burns to 80% of his body and later died.

Ignition sources

Ignition sources include:

- Open flames
- Welding arcs
- Hot surfaces
- Lighting
- Sparks from metal impact
- Arcing of electrical motors
- Discharge of static electricity
- Chemical reaction

Many processes can generate static charge, including steam cleaning, purging, and ventilation procedures. To reduce the risks from these ignition sources, use non-sparking tools and ensure all equipment is bonded or grounded properly.

A vat is a confined space in your workplace. If the material inside is fermenting, there might not be enough oxygen for you to breathe, or carbon dioxide may be present in toxic amounts. Either condition can cause you to collapse. If cleaning or welding is being done inside a confined space such as this one, hazardous gases might be produced. Before anyone enters a confined space, the space must be made safe to enter. Safety precautions include testing the atmosphere and ventilation.

Gases that may be in your workplace

Contaminant	*What is the MAIN danger?*	*What does it look/ smell like?*
Argon (Ar)	Displaces oxygen May accumulate at bottom	Colourless, odourless
Carbon dioxide (CO_2)	Displaces oxygen Toxic May accumulate at bottom	Colourless, odourless
Carbon monoxide (CO)	Toxic — asphyxiant (causing suffocation)	Colourless, odourless (NO WARNING)
Chlorine (Cl_2)	Toxic — lung and eye irritant May accumulate at bottom	Greenish yellow colour; sharp pungent odour
Gasoline vapours	Fire and explosion May accumulate at bottom	Colourless; sweet odour
Hydrogen sulfide (H_2S)	Extremely flammable Very toxic — causes lung failure May accumulate at bottom	Colourless; rotten egg odour*
Methane (CH_4)	Fire and explosion May accumulate at top	Colourless, odourless (NO WARNING)
Nitrogen (N_2)	Displaces oxygen	Colourless, odourless (NO WARNING)
Nitrogen dioxide (NO_2)	Toxic — severe lung irritant May accumulate at bottom	Reddish brown; pungent odour
Sulfur dioxide (SO_2)	Toxic — severe lung irritant May accumulate at bottom	Colourless; rotten, suffocating odour
Oxygen (O_2)	Low levels — asphyxiant High levels — causes spontaneous combustion, explosion	Colourless, odourless

* Exposure deadens the sense of smell, which means you could be walking TOWARD rather than AWAY from the source and not know it!

NOTE: Combining chemicals may result in a toxic gas being released. Always read the Material Safety Data Sheet to get the information you need about mixing two products.

Explosive or flammable?	*Industry examples*
NO	Used when welding inside confined space.
NO	Fermentation process in wine storage and fermentation tanks.
YES	Produced by gas or propane.
NO	Could leak into confined space from nearby tanks or piping containing chlorine; piping inflows.
YES, VERY!	Use of gasoline inside a confined space; vapours from spills of gasoline nearby.
YES	Rotting matter has bacteria generating H_2S. In pulp and paper mills, sewers, treatment plants.
YES, VERY!	Rotting matter will generate methane. In sewers, storage tanks.
NO	Inerting a vessel to displace the oxygen to prevent corrosion. In boilers, storage tanks.
NO	Produced by internal combustion engines, tools, and equipment that run on gasoline, propane, or diesel.
NO	Nearby tanks or piping containing sulfur dioxide that could leak; piping inflows.
Supports combustion	Bacteria, rusting, and internal combustion engines will use up oxygen; other gases can replace oxygen. In ballast tanks, boilers, double hulls, utility vaults, septic tanks, vats, manure pits, wine storage and fermentation tanks, reaction vessels, storage tanks, fuel tanks, tank cars, tank trucks, kilns. Welding inside any confined space may decrease the level of oxygen.

Physical hazards

Loose and unstable materials

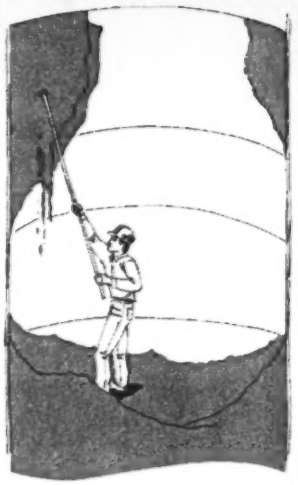
Whenever unstable solids made of small particles like sand or grain are stored in enclosures, there is a danger of the materials flowing onto workers and trapping or burying them. Examples of these confined spaces are sand bins, wood chip or sawdust bins, storage or grain silos, and potash feed systems.

Granular materials, particularly if moist, can form bridges (or shoulders) above workers. If jarred, these can collapse onto a worker.

Bins and hoppers in which materials are conveyed or augered into the bin are particularly dangerous. A worker may be trapped or crushed when material is accidentally discharged into an empty bin or hopper.

The design of these confined spaces may increase the danger of being trapped or buried. For example, in an empty hopper with a floor that slopes steeply to a vertical chute, a worker can slide into the chute and become trapped there.

Hazard alert



Salt had stuck to the walls of a salt storage bin and the worker was sent inside to remove the salt. It fell off the sides and buried him.

Wherever there are loose, unstable materials that could trap or bury you, a qualified person must inspect the space and assess the hazards. Do not enter until the hazard has been eliminated or controlled. Specific training and safety precautions must be in place before you enter.

Slip, trip, and fall hazards

The space you are about to enter may have a hatchway that is difficult to squeeze through, and ladders for ascending or descending. You are therefore at risk of falling while getting into the space as well as while you are inside. In addition, the flooring of tanks or other wet environments or the rungs of a ladder may be very slippery.

If the hazard cannot be eliminated and there is a danger of falling from a height, a fall protection system (such as guardrails or a harness and lifeline) may be needed.

Falling objects

In a confined space there may be the danger of being struck by falling objects such as tools or equipment, particularly if access ports or workstations are located above workers.

If workers might be exposed to the hazard of falling objects, safe work procedures must be put in place to prevent this. For example, schedule work activity so that no worker is working above another, and lower equipment and tools into the space *before* workers enter and remove them *after* workers leave the space.

Moving parts of equipment and machinery

Mechanical equipment such as augers, mixers, or rotating tanks can be dangerous if activated or not secured. Residual energy, such as gravity or accumulated pressure, may also pose a risk unless the equipment is locked out and de-energized. This must be done by following a written lockout procedure that is specific for each piece of equipment and that states each place where a lock must be applied. Even when the power is shut off and the equipment is locked out at control points, unsecured equipment can move, especially if it is out of balance.

Before doing any work in confined spaces:

- Shut the power off
- Ensure that the equipment is locked out at control points
- Test the lockout
- Secure any equipment that can move, even when it has been locked out

Hazard alert

Worker caught in ribbon blender inside tank

Two workers were cleaning a tank in a fish-processing plant. The tank had a ribbon blender that had not been locked out. One worker was given a water hose, which accidentally contacted the "on" switch for the ribbon blender. The worker suffered severe injuries to his lower body when the ribbon blender activated. Although other workers and emergency services tried to free him, he died while still caught in the blades of the ribbon blender.

Electrical shock

Electrical shock can result from defective extension cords, welding cables, or other electrical equipment. Work done in metal enclosures or in wet conditions can be particularly dangerous. Install ground fault circuit interrupters (GFCIs) or use assured grounding where there may be a danger of electrical shock. All electrical sources that pose a hazard to workers inside the space **must** be locked out following the written lockout procedure for the particular confined space.

Substances entering through piping

Piping adjacent to a confined space could contain liquids or gases or other harmful substances. If these substances enter the confined space, the hazards may include:

- Toxic gases
- Burns from hot substances
- Drowning
- Being trapped, crushed, or buried

Substances must be prevented from entering the confined space through piping. This is done by "isolating" the piping from the confined space. The method often involves disconnecting the piping or putting solid plates to block off the piping from the confined space. If valves are used to isolate the piping, a special double-block system must be used so that nothing can leak into the confined space.

Poor visibility

Poor visibility increases the risk of accidents and makes it harder for a standby person to see a worker who may be in distress. If poor visibility results from inadequate lighting, the light levels should be increased (although area lighting is not always required). If activities such as sandblasting or welding result in poor visibility, appropriate ventilation may be needed to reduce harmful substances in the air.

If portable lighting is used where there may be an explosive atmosphere, the lighting must be "explosion-proof." (The *Canadian Electrical Code* has a description of lighting that is approved for use in explosive atmospheres.)

Emergency lighting such as flashlights or battery-operated area units must be provided where necessary, so that workers can locate exits and escape.

Temperature extremes

Special precautions are needed before workers enter equipment such as boilers, reaction vessels, and low-temperature systems. A qualified person must provide these procedures. Allow enough time for cooling of confined spaces that have been steam-cleaned.

Noise

Noise produced in confined spaces can be particularly harmful because of reflection off walls. Noise levels from a source inside a small confined space can be up to 10 times greater than the same source placed outdoors. If the noise levels cannot be reduced, proper hearing protection **must** be worn where necessary.

Hazard alert

Noise causes hearing loss

A boilermaker removing tubes inside a heat exchanger with the aid of a pneumatic tool was exposed to 120 decibels of noise. This was sufficient to cause major temporary hearing loss after a few minutes of exposure.

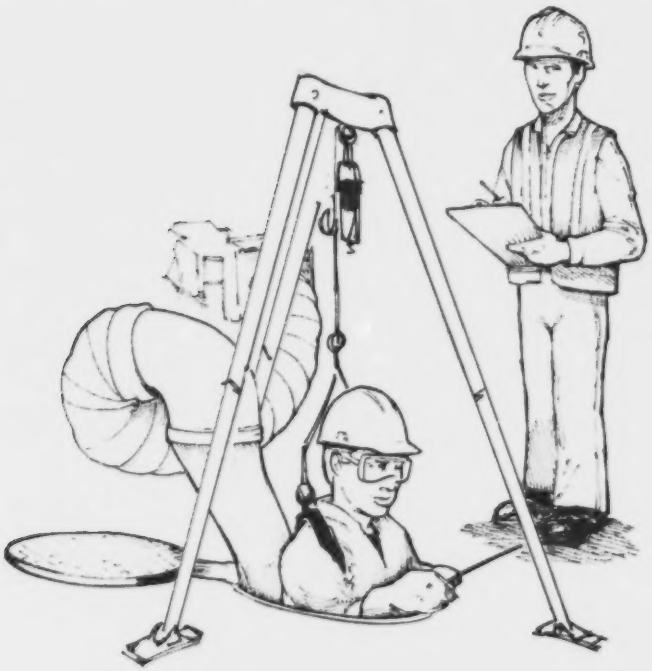
Risk of drowning

Confined spaces should be fully drained or dry when entered. Spaces that are not fully drained or dry may pose a risk of drowning. The risk of drowning in a vat or tank with a large amount of liquid is easily recognized. However, workers have drowned in small pools of liquid. For example, insufficient oxygen, the presence of a toxic gas, or a blow to the head can make workers unconscious. Workers who have fallen face-down into a small pool of water have drowned.

Confined space entry program

Before workers perform work in a confined space, the employer **must** prepare and implement a written confined space entry program.

The identification, evaluation, and control of confined space hazards are often quite complex. For assistance in assessing the hazards and preparing a written confined space entry program, consult a qualified occupational health and safety professional. The health and safety professional can tell you what to do to make it safe to enter a confined space, including providing the appropriate air-testing equipment, and explaining the portable air-moving device and the personal protective equipment to be used.



A well-thought-out rescue plan, proper equipment, and training and practice sessions are key to keeping workers safe if they must enter a confined space.

The confined space entry program **must** include the following:

- An assignment of **responsibilities**.
- A list of each confined space or group of similar spaces, and a **written hazard assessment** of those spaces prepared by a qualified person.

- **Written safe work procedures** for entry into and work in each of the confined spaces. Each procedure must be written specifically for each of the hazards that exist in each space during each entry.
- The **equipment** necessary for each entry must also be provided, including testing devices, air-moving devices, isolation and lockout devices, and personal protective equipment.
- A **signed** permit where required.
- **Training** of employees.
- A **rescue plan**.

REMEMBER!

Every worker has the right to refuse unsafe work. If you believe the space is unsafe to enter, do not enter it. Make sure all the safety precautions are in place.

Notes

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